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Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY

Old Series Vol. 27 TORONTO, JULY, 1914 New Series Vol. IX. No. 3

OUR BELOVED DEAN GALBRAITH

On Wednesday, July 22nd, we received the sad news that Dean Galbraith had passed away early that morning at his summer cottage on Go-Home Bay, Muskoka. The message came as a shock to his very many friends, for although he had not been en-enjoying very robust health for some time, he displayed such resolute fortitude and presented so cheerful a front, that no one suspected that the end was near. We all cherished the hope that after a quiet summer at his home in Muskoka he would return with renewed vitality to assume his duties and to welcome back his engineering family over which he had presided and with whom he had patiently labored since the birth of the institution.

For several years Dr. Galbraith had been suffering from heart trouble, but he never made any complaints. His benevolent consideration for others led him to bear his troubles patiently and with admirable endurance, and in spite of his indisposition, he always attended with unbroken regularity to his many arduous duties.

He had not been as well as usual since the close of the academic year in April, and for a part of the time he was confined to his bed at intervals. It was thought a few months at his favorite abode would renew his strength and so he and Mrs. Galbraith and their younger son, Douglas, went to Go-Home early in July. The Dean, being a close companion and an ardent student of nature, felt a peaceful invigorating influence in his new environment and began to feel much stronger.

On the evening before his death, while he was having dinner on the verandah of the cottage with members of the family and friends, he remarked on the quiet beauty of the evening and thought that surely no one could wish for anything nicer than what had been their lot that day. He was in great spirits and sat on the verandah until late in the evening admiring and enjoying, with the true appreciation of a lover of nature, the quiet solitude of the surroundings as the sun in all its splendor, sank behind the horizon.

When he had retired a short while he was seized with a chill, no doubt due to a weakening of the heart, but he soon felt better and insisted that they should retire again, stating that he would be quite well in the morning. However, about four o'clock the family were summoned to his bedside and he peacefully passed away without awaking from a quiet sleep. In the quiet solitude of the early morning a noble life in all its splendor sank behind the horizon of mortality to cast off the earthly burden of clay, and awake arrayed with celestial radiance, in the Mansion which he had been building with his good and noble deeds on earth.

The remains were brought to Toronto on Thursday evening, and after the funeral service on Saturday afternoon at the Church of the Redeemer, were conveyed to Mount Pleasant Cemetery for interment. It is certain that a more impressive or more representative funeral was never held in Toronto. Every engineering class since the founding of the "School" was represented and engineering organizations throughout and beyond the Dominion paid tribute to the father of engineering in Canada. The Provincial and Dominion Governments expressed their appreciation of one of the greatest builders of the country which they represent. Prominent engineers from Canada and United States attended, to show their respect for the leader of the profession in Canada. The floral tributes from the numerous engineering organizations and the various year classes of graduates and undergraduates, as well as from personal friends and many other sources, expressed in no uncertain tone the continent wide admiration with which the Dean was regarded, and the deep regret which was felt at his unexpected death.

Dr. Galbraith was born of Scotch parentage in Montreal on September 5th, 1846. He received his early education at Port Hope and registered in arts at the University of Toronto in the fall of 1863. In 1868 he graduated, receiving the degree of B.A., with a double scholarship in mathematics and general proficiency. He was gold medallist in Honour Mathematics, and he won the Prince's prize for highest general proficiency, established by the late King Edward VII during his visit to Canada, when he was Prince of Wales. He received the degree of M.A. from the University of Toronto in 1875. In 1902 the honorary degree of LL.D. was conferred upon him by his alma mater, and in 1903 Queen's University honored him with the same degree.

In 1886 he married Miss Emily Stupart, youngest daughter of the late Capt. R. D. Stupart, R.N. His widow and one daughter, Beatrix, and two sons, John Stupart, of the engineering staff of the Toronto Harbor Commission, and Douglas, an undergraduate in civil engineering at the University, survive him.

Dr. Galbraith was one of that body of eminent men whose working life has been contemporaneous with that of the Dominion, and who with quiet and consistent patriotism have struggled for its

upbuilding and have prospered with its growth. With the establishment of Confederation there came an outburst of engineering activity, especially in transportation work, throughout the settled portions of Canada. Upon graduation, Dr. Galbraith found employment in the railroad field, getting his professional training as apprentice to Professor L. B. Stewart's father, Mr. Geo. A. Stewart, at that time chief engineer of the Midland Railway, and also an engineer and surveyor of extensive private practice. He completed his apprenticeship, qualifying as provincial and also Dominion land surveyor. In 1871, after a year's service as contractor's engineer on the construction of the Intercolonial Railway, then being built by the Dominion Government, he returned to the Midland Railway as resident engineer, and afterwards division engineer, on the Midland Railway extension to Georgian Bay. From 1875 to 1877 he was employed on surveys for the Canadian Pacific main lines, then under direct government control, and for the projected Georgian Bay branch of that undertkaing.

Upon the founding of the School of Practical Science in 1878, Dr. Galbraith was appointed to the chair of engineering and in 1889 was made Principal of the "School." In June, 1906, the "School" became the Faculty of Applied Science and Engineering of the University of Toronto, and Dr. Galbraith was appointed Dean of the Faculty, which position he so ably and nobly filled until the time of his death.

His activities were by no means limited to his academic work, although it received his first attention, he having consistently refused to undertake professional work as a consulting engineer whenever it was likely to interfere with his work at the "School." He has occupied many honorary positions, including those of vice-president of the Ontario Land Surveyors' Association, vice-president of the Engineering Section of the British Association for the Advancement of Science, vice-president of the Engineering Section of the American Association for the Advancement of Science, and vice-president of the Canadian Institute, Toronto. He was an associate member of the Institute of Civil Engineers, England, and was one of the founders of the Canadian Society of Civil Engineers, of which society he was a councillor for many years, and of which he was elected president in 1909.

When, in 1907, the engineering world was startled by the fall of the Quebec Bridge, it was recognized in Canada that the disaster must be investigated by commissioners of unquestioned impartiality and integrity and of sound engineering knowledge, whose conclusions would be unhesitatingly received by the country at large, the undertaking having been practically a Government work. Dr. Galbraith was appointed a member of the commission to inquire into the cause of the disaster, his ability as an engineer having long before been realized by the engineering profession. The thoroughness and com-

prehensiveness of their report speaks volumes for the capable and painstaking work of the commission, and contributes a valuable addition to the engineering literature of to-day.

On November 4th, 1908, the graduates and undergraduates in engineering presented the University with a large portrait of their Dean, in recognition of the unselfish interest which he had always taken in them, and of the true worthiness of the subject of the portrait.

Although he had not quite lived the allotted span of three score years and ten, we must remember that there is breadth and depth to life as well as length. His life was broad in every sense of the word, his influence reaching out to every class of men, for he manifested an interest in every movement which appeared to be in the interests of humanity. Through his strength of mind he could control the strongest men, and revelled in the intricacies of the many weighty problems connected with his work and profession, while his kindness and largeness of heart made him the idol of children and rendered him appreciative to the fullest degree, of the beauty and healing influences of God's teacher, Nature. His benign influence penetrated the deepest depths of every heart which came within the sphere of his life, and his comprehensive understanding fathomed the deeper problems of life, and won for him a place among the men whose efforts have enthroned them on the pedestal of honor and respect.

In his demise the engineering profession has lost a leader. He had undoubtedly accomplished more in the interests of the profession in Canada than any other individual. At the time of the founding of the S.P.S., engineering education had not been introduced in Canada, and by many was not deemed practicable or worthy of serious consideration, but in spite of discouraging circumstances it was fostered by Dean Galbraith until he finally proved the justification of his contentions, which were prompted by a foresight reaching far into the future. He built up the "School" until to-day it stands among the foremost engineering colleges of the world. He has prepared thousands of young engineers to go out and develop the wealthy resources of the Dominion.

The loss to the University is indeed a serious one. His name inspired confidence in the manufacturer and in the commercial man, and as a result the University enjoyed the accumulated patronage which was the outcome of credit reflected upon it by the life and associations of Dean Galbraith. He had effected a bond among the graduates in engineering, which fostered a loyalty to their alma mater such as is not evidenced in any other faculty or in any other University.

He had always been the students' friend. He was one of the very few men of our universities, who properly appreciated the position and capacity of the undergraduate. In preparing a curriculum he always gave the students' needs his first consideration, and

did not make the curriculum suit as conveniently as possible the courses of lectures which might be given. He won many a concession for the undergraduates quite unknown to those whose cause he had championed. He always had a willing and sympathetic ear for a student in trouble, and his kind and helpful attitude won their confidence, with the result that he was looked upon by them as a real friend in whom they could confide, and whom they could approach with difficulties which confronted them. He will be missed, and sadly missed, in the corridors of the old "School" where he had been the constant recipient of well merited respect since the founding of the institution which he fostered and fashioned until his death.

His many worthy characteristics were developed and manifested to the greatest degree in his home. To those who knew him,—and our readers all knew him well,—it would be superficial to try to convey an impression of the kindness and unselfish love and companionship, which he afforded the members of his family. He was a companion to his boys and spent many days with them alone, in the pleasant retreats of Northern Ontario. He was an inspiration for good to the whole household, and his greatest enjoyment was derived from his home life.

His eulogies were spoken while he lived. Homage and tribute were paid him throughout his life, the crowning mark of respect probably being the banquet tendered to him last December in the Engineering building, by the graduates and undergraduates in engineering, in celebration of the fiftieth anniversary of his entrance to the University, and of the thirty-fifth anniversary of his appointment as head of Engineering in the University. It was a happy family reunion when over six hundred of his boys assembled, and hundreds of others too far away wired messages of appreciation, to pay tribute to the grand old man to whom they owed so much.

As President Falconer has said, he was a thoroughly trustworthy man, thorough in training, honesty, and patience. His name will be handed down to posterity as an emblem of true worth, and his life will find a prominent and enviable place in the pages of history.

The following extracts from correspondence received during the last week reveals the measure of esteem with which the Dean was regarded by the graduates and other men who had felt the influence of his personality.

The loss of Dean Galbraith will be felt far and wide throughout the Dominion, wherever there are engineering students or engineers in the active practice of their profession. He was not only a very able engineer but a man of wide human sympathies and with a great power of inspiration.

FRANK D. ADAMS,
Dean of Engineering, McGill University.

Montreal, July 28th, 1914.

Dr. Galbraith was one of the greatest men of his age, for he has been instrumental in producing the men who are now so strong a factor in the development of our Dominion.

I shall always cherish his memory with sincere affection.

H. G. Tyrrell, '86.
Consulting Engineer.

Evanston, Ill., July 24th, 1914.

Dean Galbraith was the greatest practical engineering educator of his time, and, through his graduates, he has influenced all parts of the engineering world. I count it a great privilege to have studied under him, and the friendship which has since continued makes me mourn his loss most keenly.

Louis L. Brown, '95,
Vice-president, The Foundation Co.

New York, July 25th, 1914.

For thirty-two years I had the great good fortune of the acquaintance, advice, instruction and friendship of Dean John Galbraith.

The late James Ross, a thorough judge of men, said in 1883, that Galbraith was an exceptionally capable engineer and teacher, and that any boy who was fortunate enough to graduate under his instruction would need no further collegiate training in Europe or America.

The advice given me by Dean Galbraith has been repeated to many young men, as I have felt sure that it would benefit them as it has benefitted me.

There is no man living whom I respect, admire and love as much as I did Dean Galbraith.

T. Kennard Thomson, '86,
Consulting Engineer.

New York, July 25th, 1914.

He has left his mark in Canada through his great influence. He was beloved and revered by every student who studied under him and few men will be more widely mourned.

T. R. Deacon, '91,
Mayor.

Winnipeg, Man., July 27th, 1914.

Dean Galbraith possessed, I believe, more of the Christian virtues than any other man I have known. He was of a most kindly disposition, and was considerate, almost to a fault, of the feelings of all with whom he came in contact.

For over twenty years he has been my most intimate friend,

and in this long period I cannot recall his ever having spoken uncharitably of anybody, although he occasionally expressed righteous anger at manifest wrong doings. He practiced to the fullest extent the Golden Rule, "Do unto others as you would have others do to you."

He was extremely happy and content in his home life and had practically no outside interests, other than those connected with the University and the School of Science.

R. F. Stupart,
Meterological Service.

Toronto, July 25th, 1914.

For a long while I have known him—thirty-three years—and in all that time, first as a pupil and afterwards as one of the many who had the good fortune to possess his friendship, I grew to respect more and more and admire those rare qualities of heart and mind which so endeared him to all who knew him well.

His personality was extremely attractive. He appealed to all sorts and conditions of people, to young and old, to the plain workman as well as to the educated college man.

He had all the qualities of a truly great leader. He had wonderful tact and intuition and was very, very kindly. His modesty and genial good nature, keen sense of humor, and charity for human weaknesses, gained him friends everywhere, and yet when necessary, he could be very strong, but he ruled through love and not through force.

He possessed the faculty to a remarkable degree of imparting knowledge to others, and of stimulating a desire for thoroughness. I have met none who were his equal in this respect. There was something in him which unconsciously brought out the best in his pupils. I do not remember that he ever lectured his class on conduct or ethics; but his influence somehow stimulated the best that was in us. He was not only a great teacher of Applied Science—he was an upbuilder of character—he made Men as well as Engineers.

His loss to Canada and to the University is very great. To his wife and family and to his many devoted friends, it is irreparable; but he had lived to see the fruition of his life's work, and it gave him much joy in his later years to see the bountiful return which his early strenuous and loyal work had produced. The influence of his life will long survive him. The world is better for John Galbraith having lived.

Eugene W. Stern, '84,
Consulting Engineer.

New York City, July 24th, 1914.

Dean Galbraith's death is a great personal loss to me. When I came under his instruction in 1880, there were, I think, only ten

undergraduates. I was his first assistant in 1884, and at that time had the advantage of much intercourse with him. It was but natural that those qualities that have endeared him to so many appealed to me and have increased my regard in these thirty-four years.

Dean Galbraith's achievement in making the School of Science and the Engineering Faculty of Toronto University what it is to-day is a goal that few have won. It has been the lot of few men to gain the affection and respect of all in the same generous measure as he did and nothing can add to these testimonies of his sterling character, his humanity and ability.

The manner in which the graduates and his fellow engineers seized opportunities to honor him could only have been possible to a man of his exceptional parts.

It was natural that we, of more intimate intercourse with him, should have felt his influence, but it has been a constant wonder and pride to us that all the graduates of all the intervening years should have kept his personality and name as the reason for the esprit-de-corps of the School.

We older graduates have realized that the growth and influence of the "School" was in large measure due to the example and the enthusiasm inspired by its principal.

The "School" will, of course, sorely miss his leadership, but his name will still remain a watchword and we must console ourselves with the knowledge of what he accomplished. His life's work could hardly have been more complete.

G. H. Duggan, '83.

Vice-president and Chief Engineer, Dominion Bridge Co.,
Chief Engineer, St. Lawrence Bridge Co.

Montreal, July 27th, 1914.

THE PURIFICATION OF PUBLIC WATER SUPPLIES

C. H. R. FULLER, B.A.Sc.

(Concluded from last issue)

Purification of Water for Drinking Purposes

SEDIMENTATION PROCESSES.—Impure water has a tendency to become purer if left standing. The process of sedimentation consists in taking water through basins in which the velocity of flow is reduced and the heavier suspended matters sink to the bottom by gravity. Sedimentation is now largely used as a process preliminary to the purification to which the water supply is subjected. There are two principal methods of sedimentation: (1) Plain Sedimentation. (2) Sedimentation with coagulants.

PLAIN SEDIMENTATION.—This consists of allowing the water to enter reservoirs and to remain for a certain period of time until the water becomes clarified. Where water is to be filtered after sedimentation, a high degree of clarification is not needed although the reduction of suspended matter should be great enough to avoid clogging the filter beds and to reduce the frequency of cleaning.

A period of twenty-four hours' subsidence is about the minimum limit, although in some cases a shorter period is used. At Cincinnati a delay occurred in completing a second reservoir. The first reservoir was in constant service and a period of subsidence of 8 to 10 hours was all that could be allowed. It was found that during the months when the turbidity of the Ohio river water ran over 100 parts per million, an average of 48 per cent. of suspended particles was removed in passing through the reservoir. On the completion of the second reservoir it was found possible to allow three days' sedimentation before filtration. The average removal of suspended matter was as follows:

Time of Subsidence	Amount of Suspended Matter Removed
24 hours	62 per cent.
48 hours	68 per cent.
72 hours	72 per cent.
96 hours	76 per cent.

The average capacity of each reservoir is 160,000,000 gallons. The plan used is to draw water from one reservoir while the other is filling. This allows a period of subsidence averaging 40 hours for each reservoir. The reservoirs are formed by the construction of two earth dams across the lower end of two branches of Lick Run, a tributary of the Little Miami River and by excavations and embankments necessary to remove unsuitable material and to reduce the surface of the ground above the dams to uniform slopes and grades. The interior surfaces of the reservoirs so formed were covered with a blanket of rolled clay not less than 3 feet thick. A stone curb one foot thick and three feet deep was set, with its top around the upper end of the slope of each reservoir. For 36 feet below this, the slopes were covered with a 12 inch layer of crushed stone and gravel mixed with sand. Upon this layer of stone and

gravel, a six inch layer of compressed Portland cement concrete was spread and covered with a smooth coat of cement mortar. This layer of concrete was covered with a mixture of asphalt which was applied hot in two coats one-eighth inch thick. The second coat was covered with a layer of vitrified brick while still hot and the joints filled with cement grout. The bottoms of the reservoirs dip from there 108.50 at the southerly ends to elev. 89.00 at the floating tube piers back of the dams at the northerly ends of the reservoirs.

The water enters each reservoir over the cascade and is taken out through two steel riveted floating tubes four feet in diameter, which by means of swinging elbows, connect with two five-foot diameter cast-iron effluent pipes which pass down through the masonry pier into a brick archway (See Fig. 1). This archway, which is 16 feet in diameter, passes under the dam at an elevation of 60.00 and terminates in a brick shaft outside of, and at the foot of the dam. The shaft is 18 feet in diameter and rises to elev. 98.00,

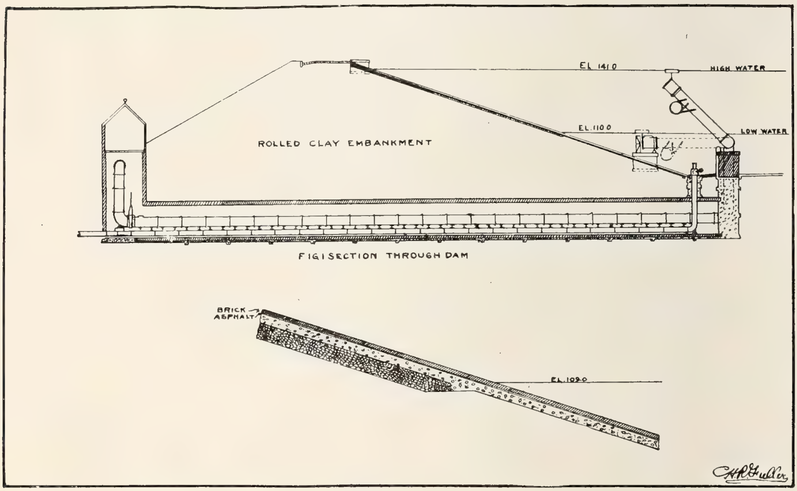


Fig. 1 and Fig. 2—Enlarged Section of Revetment

above which it terminates in a circular shaft house. The effluent pipes pass through the archway, up through and out of the shaft at elev. 93.00 where they connect with each other and with two like effluent pipes from the adjoining reservoir. Gate valves on these effluent pipes at the bottom of the shafts on the connections outside of the shafts permit the water to be drawn down through either one or both of the five foot cast iron mains which convey the settled water to the filtration works. Provision is made for washing the accumulated sediment out of either reservoir by means of large effective hose streams which cut up and carry the mud to four drainage outlets in the bottom of each reservoir. The drain pipes pass as a 30 in. cast iron main through the archway and out at the bottom

of the shaft. Mud valves over the outlets, operated by hydraulic pressure and a gate valve at the bottom of the shaft, control the draining and washing of the reservoir.

An overflow connection 15 feet wide and 92 feet long between the two reservoirs prevents the water in either reservoir from rising above elev. 142.50. The slopes were trimmed and sodded to add to the general appearance of the grounds. The accompanying drawings Fig. 1 and 2 show a sectional view of the dam and a section of revetment.

Cincinnati is one of the few cities on the American continent using the Sedimentation Process on a large scale. In Toronto there is a danger of the lake water clogging the slow sand filter beds of the present plant. If this occurs, a plain settling reservoir of sufficient size would probably be a remedy.

Sedimentation with Coagulants.—It is known that various chemicals when added to water will combine with the fine suspended matters causing precipitation of relatively large masses which may be more readily removed by filtration. The use of coagulants with water is generally employed as a process preliminary to rapid sand filtration as it enables the filters to be operated at a high rate.

Sulphate of Alumina, commonly called Alum, is perhaps the most widely used coagulant. When this substance is introduced into water containing carbonates of lime and magnesia, the alumina unites with the water to form a bulky gelatinous hydrate, which is the coagulating agent. This is absorbed by the clay particles of suspended matter. It is important to use only the amount of alumina which will combine with the quantity of carbonates present, as an overdose may have injurious effects. Theoretically, one grain of sulphate of alumina will decompose 8 parts per million of carbonates. In practice the amount of chemical required depends on the amount and character of the sediment, on the degree of purification required and the time of settlement. For a preliminary treatment a high degree of efficiency is not necessary and it is customary to reduce the suspended matter only 45 parts per million, allowing about 6 to 8 hours sedimentation.

For waters with suspended matter running from 100 to 200 parts per million, 0.7 to 2.0 grains of alumina per gallon is necessary. In Saskatoon, where a new filtration plant of the rapid sand type was recently installed, the suspended matter varied from 130 to 400 parts per million. It was considered necessary to use 1.52 grains per gallon of alumina during periods of excessive turbidity and 0.28 grains per gallon for periods of normal turbidity. The cost of sulphate of alumina varies from $2.20 to $2.40 per hundred weight.

Coagulation is also produced by the use of ferrous sulphate and caustic lime in the form of milk of lime. Where the alkalinity of water is low, this coagulant may be used with good results. It is quite as efficient as sulphate of alumina, and its cost is considerably less. It, therefore, is considerably more economical for use in those waters where experiments show that it can be used successfully. Where the amount of suspended matter is over 50 parts per million,

it is considered advisable to use coagulants instead of plain sedimentation.

In the operation of settling basins using coagulants, the continuous flow system is universally used. The water is given a brief period of sedimentation. Where the water is rather high in turbidity two basins are needed in order that one may be cleaned without interrupting the supply. This effect can be secured by an inexpensive partition in a single basin.

A necessary precaution in using alum as a coagulant is to pave the floor of the basins with asphalt; otherwise the alum will attack the concrete, decomposing it and causing sand to accumulate in the bottom of the tanks. All exposed metal surfaces in tanks should be coated with red lead.

FILTRATION PROCESSES

Slow Sand Filtration

It is well known that sand is a universal filter medium. The main improvement in filtered water is the removal of the suspended matter and the elimination of bacteria and other micro-organisms. When working under favorable conditions, a sand filter will remove 98 per cent. of bacteria present in the raw water. The effluent on the first day of operation will contain organic matter and bacteria. As the filter is kept working the organic matter decreases and fewer bacteria are found in the effluent. This is explained by the fact that a jelly-like deposit is forming at the surface and also there is an appreciable action of a similar nature going on in the depth of the filter. This substance contains many minute organisms which destroy the bacteria, and arrests the organic matter. After a time even the water passes too slowly and a layer is scraped off the top of the filter.

In the design of a filter plant the first question to be settled is the adoption of a rate of filtration. In Europe the practice is to use a rate of from two to three million gallons per acre per day; while in America the rate varies from three to six million gallons per day, depending on the turbidity of the water. Sudden changes in the rate of filtration should be avoided, especially any large increase over the normal.

To economize area and to avoid rapid changes in rate, a pure water reservoir should be provided. It should have a sufficient capacity to equalize the demand throughout the day. It is customary to assume the maximum daily rate of consumption to be 150 per cent. above the average and the filters are usually designed to deliver at this maximum rate. A reserve area for cleaning must also be provided, usually one bed to every five or ten beds.

The proper size of beds is a question of economical construction. The larger the beds, the less is the cost per acre. Covered beds, which are generally used, vary in size from 0.4 to 0.8 acres.

The following calculation is of assistance in determining the economical number and size of beds. The cost of a filter may be estimated as made up of two items (1) a portion proportional to the area, which would include cost of bottom, filling, small drains, cover,

and the end walls, assuming basins rectangular and placed side by side, and (2) a portion nearly independent of the size, such as cost of piping, valves, valve chamber, division walls, etc.

Let c = Cost of first portion per acre.
and C = the cost of the latter portion per filter.
If q = area of one filter
n = number of filters
A = Total net area required.

Then, assuming one filter in reserve

$$n = \frac{A}{q} + 1 \qquad (1)$$

The total cost is

$$K = Cn + cnq \qquad (2)$$

$$= C\left(\frac{A}{q} + 1\right) + cq\left(\frac{A}{q} + 1\right)$$

$$= \frac{CA}{q} + C + cA + cq \qquad (3)$$

We then have $\frac{dK}{dq} = \frac{CA}{q^2} + c$

When for a minimum cost

$$q^2 = \frac{C}{c} A \qquad (4)$$

i. e. the economical area of one filter is proportional to $\sqrt{A}$ and to $\sqrt{\frac{C}{c}}$.

The larger the value of "c," the smaller is "q". The values of $\frac{\text{“}C\text{”}}{c}$ will hardly be larger than 1/9 or less than 1/16, giving a value of "q" = $1/4\sqrt{A}$ to $1/3\sqrt{A}$. Thus, when A = 9 acres, the capacity q = 3/4 to 1 acre giving 9 to 12 beds. Where A = 1 acre, the capacity would be 1/4 to 1/3 acre giving 3 to 4 beds. Larger beds than 1 acre are undesirable on account of increased difficulty of operation.

Filter beds are usually rectangular and arranged side by side. It is usual to place them in two rows with a space between for sand washing, regulating houses, etc. The economical proportions of the beds is given by the following formula:

$$\frac{b}{a} = \frac{n + 1}{2n}$$

where b = width, a = length, and n = number of beds in a row.

Concrete, well reinforced is generally used in construction of the filters. The covers are constructed either of plain or reinforced concrete and are of the groined arch type.

At Toronto, there has recently been erected a very modern slow sand filtration plant, a description of which it is considered well to give, as this may be used as a standard in plants of this nature.

Toronto is situated on the north shore of Lake Ontario. Along the front of the city is a long low island composed entirely of lake sand and gravel. The intake of the city water supply lies in about 50 feet of water at a point one-half a mile south of the southernmost point of the island. From the intake a six foot steel pipe runs to the shore of the island, across the bay through a tunnel to the main pumping station of the waterworks system.

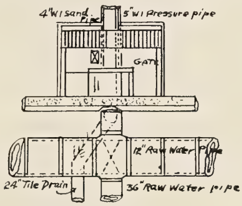
The population of Toronto is about 450,000. The per capita consumption is about 130 U.S. gallons per day. The rate of filtration assumed in the design of the plant was 6,000,000 gallons per acre per day. The size of the beds is about 0.8 acres. A low lift pumping station was designed to give the necessary lift to overcome the friction through the filters and the piping. The filters are laid out in two rows of six filters on either side of a central court. The effluent pipes from the filters run to two regulator houses in the central court and from these regulator houses another large concrete pipe carries the filtered water to the pure water reservoir which has a capacity of 7,500,000 gallons. A short line of 72 in. concrete pipe connects the pure water reservoir with the 6 ft. steel pipe crossing the island. The water is lifted at the pumping station to the level of the filters which is naturally above the lake level and flows through the filters, regulator houses, etc., into the pure water reservoir and thence into the 6 ft. pipe, at an elevation which gives practically the same condition for operation of the pumps at the main pumping station in the city as existed before the plant was in operation. The general arrangement of the plant and other features are shown in Fig. 3.

The filter floors were placed directly on the sand as excavated. Care was taken to avoid carrying the excavation at any point below the grade of the floors, as well as precautions to wet and compact the exposed sand surface before placing each floor block. So far there is no evidence of large or unequal settlement although the structures have stood full of water for more than a year. The floor blocks were placed in alterante sections, the intermediate sections being laid afterwards and screeded to the first ones laid. The groined arch vaulting was placed as is usual, in alternate sections.

The main drain of the filter was formed as a depressed section of the concrete floor with a cover slab of reinforced concrete placed across the top of the low side-walls of the drain. The reinforced concrete cover slab is made to fill in completely the space between the two pier foundations upon either side of the drain, in order that there may be no lack of continuity in the arch action at that point to resist the thrust. The entrance houses to the filters contain the sluice gates, controlling the flow of unfiltered water to the filters and also the gate valves controlling the discharge from above the surface of the filters to the waste drain. This is shown on the plan of the entrance house in Fig. 3.

The lower layers of the filtering material consist of gravel and crushed stone. It was placed in three layers. The first has a depth of 7 inches and consists of gravel or stone which is retained on a

one inch screen and generally not larger than two inches. The second layer has a depth of two and a half inches and consists of material which passes a one inch screen and is retained on a 3/8 inch screen. The third layer has a depth of 2½ inches and consists of material which passes a 3/8 inch screen and which has an effective



Plan of Filter Entrance

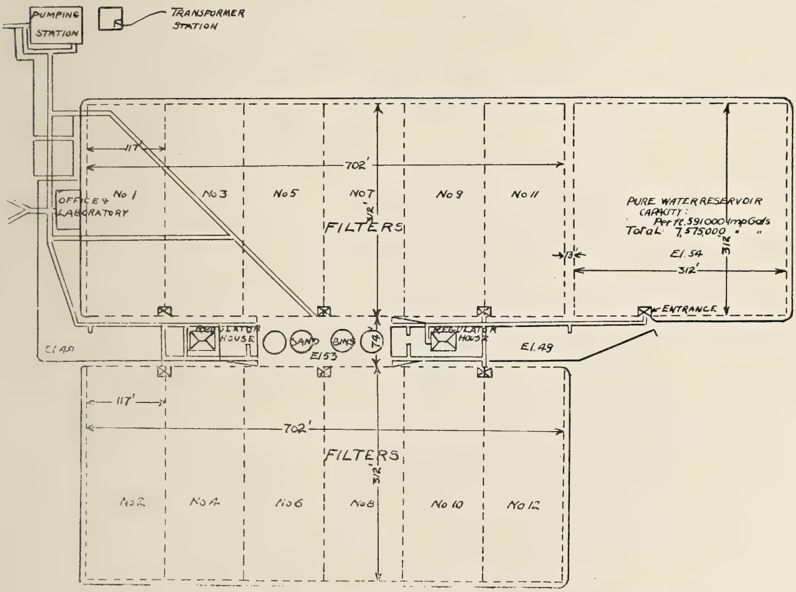


Fig. 3—General Plan of New Water Filtration Plant at Toronto

size of about three or four mm. The specifications called for an effective grain size of sand of 0.25 mm. to 0.35 mm. and a uniformity co-efficient not greater than 3.

A complete system of drainage is provided for the plant. This consists of a main drain of 36 in. concrete pipe with 24 in. branches of vitrified tile entirely surrounded with concrete from various filter entrances and numerous smaller connections with catch-basins, sand bins, sand washers, electric and duct manholes, etc.

The sand washers are in principle similar to the ones designed for Washington and Springfield, consisting briefly of reinforced concrete hoppers into which the slush of dirty sand and water from the filters

is discharged. A jet of water subject to adjustment is admitted into each of these hoppers at the bottom, causing a vertical velocity of water in the hopper, which is designed to carry the dirty water away at the overflow while still permitting the scrubbed sand to fall freely into the bottom of the hopper, where it is picked up by an ejector and carried forward to the sand storage bins.

Mechanical or Rapid Sand Filtration

Rapid sand filtration first attracted attention as a method of purifying water supplies in 1885, when a small rapid filter plant was built to treat the supply of Somerville, N.S. Since that time this method has come into use in more than 350 cities in different parts of the world and supplies a total daily demand of considerably over 700,000,000 gallons. The largest plant of this type is installed at Cincinnati, Ohio. Others are located at Columbus, Ohio, Hackensack, N.J., Little Falls, N.J., and Saskatoon, Canada.

The essential differences between rapid and slow sand filters are as follows. In rapid sand filters, the rate of filtration is very much higher (100 to 125 million gallons per acre per day); the filter units are much smaller; the sand grains comprising the filter bed are much coarser; a coagulant is always used in preparing the raw water for final filtration, and the whole filter bed, when dirty, is cleaned in the tank itself by forcing water upward through the sand instead of scraping off the surface layers as in slow sand filters.

These peculiarities lead to a difference in construction from that of the slow sand type. The units are relatively small in area, the coagulating basin becomes an essential part to the plant and the sand washing which must be done every few hours requires special devices. Nearly all rapid filter plants are now built of concrete, although wooden and steel tanks are still used. The filter tanks are ordinarily built of monolithic concrete and embedded in the floor of the tanks is the underdraining system, composed of perforated pipes or strainer cups, designed to permit the filtered water to pass out without allowing sand to escape and to permit an even distribution of water throughout the sand layer when the filter is being washed. Over the strainer system a shallow layer of coarse sand or gravel is placed, and on this rests the sand layer which forms the filter proper. When the raw water has been sufficiently clarified by coagulation, and sedimentation, it is passed on to the surface of the filter, over which water ordinarily stands to a depth of several feet, and allowed to pass downward through the bed at a rate of 100,000,000 to 125,000,000 gallons an acre daily, such rates being automatically controlled by special devices.

The water supplied to the filter always contains a considerable amount of coagulated matter, such as mud, vegetable stain and bacteria, which is retained at or near the surface of the bed. As operation is continued the frictional resistance in the sand layer increases to a point where it is necessary to close the filter for washing. At such times the water standing over the bed is drained down to the level of the overflow gutters which are located a foot or more

above the sand layer, and filtered water is then forced upward through the filter, being evenly distributed by means of the strainer system. Water is forced backward through the strainers and at the same time the sand is stirred up to its full depth by means of long iron fingers which reach into the sand, and which are attached to a transverse arm mounted on a vertical shaft, the whole being rotated by means of suitable gearing.

The rapid filters just described are known as "Gravity" filters and are contained in open tanks.

Pressure Filters.—In this filter the entire bed is enclosed in a cylindrical steel tank. One of the best types of this is that manufactured by the Bell Filtration Co. of Toronto. The accompanying cut, Fig. 4, shows a view of the internal arrangement of the filter.

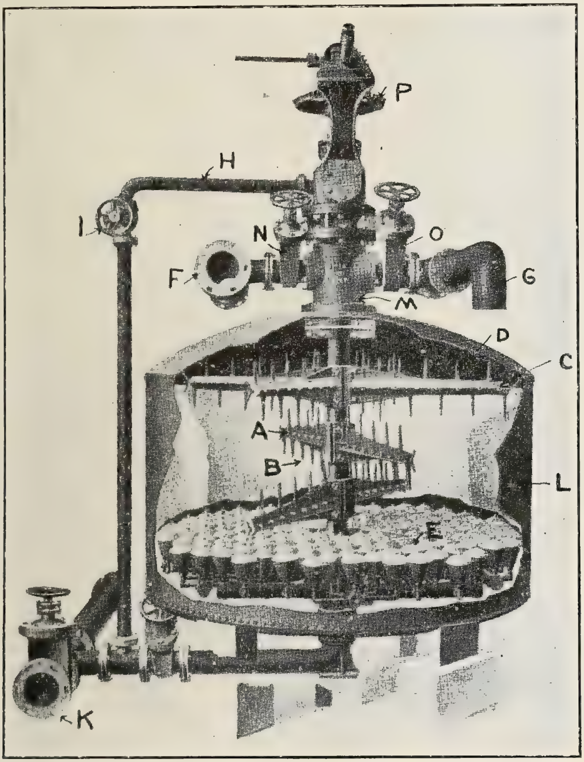


Fig. 4

A—Valves in Wash Arms.
B—Rakes on Wash Arms.
C—Hydraulic Hollow Wash Arms.
D—Hydraulic Hollow Shafts.
E—Perforated Strainers.
F—Inlet Pipe for dirty water.
G—Washout Pipe for Cleaning.
H—Top Pipe.
I—Vertical Wash Valve.
K—Outlet for Filtered Water.
L—Steel Filter Shell.
M—Top Block on Shell.
N—Inlet Valve for Dirty Water.
O—Wash Out Valve.
P—Bevel Wheels.

The shells "L" are made of mild steel and are so constructed that when in operation an ample margin of strength is provided for. After being mixed with a suitable amount of chemical, the water to be filtered is passed into pipe "F" and through inlet valve "N" into the top block on shell "M" and into the top of filter shell "L," then after passing through filtering material it is collected by strainers "E" and passes out through the bottom pipe into the main filtered water discharge pipe and out through valve "K."

The process of filtering is continued until the pressure gauge shown on illustration on inlet pipe indicates that the resistance from accumulated dirt makes it necessary to wash the filtering material.

The Bell plants are erected in batteries, each separate filter doing the same amount of filtering. The size of installation depends upon the quantity of water to be filtered.

Since pressure filters are erected in batteries with a common filtered water main, one or more filters are washed in one operation, the number depending on the size of the plant; the remainder continue to filter. Only filtered water is used in removing the collected impurities from the filtering material. The washout valves "O" (see figure) of the compartments to be washed are opened and the inlet valves are shut. Valve "K" is partially shut. A current of clean water is forced through bottom pipe and strainers "E" upwards through the filtering beds, putting the same in suspension, the water flowing through the top blocks "M" and valves "O" and out through pipe "G"; as soon as the beds are in suspension, vertical wash valves "I" are opened and a current of water is passed through top pipes "H" into hollow shafts "D" and into hollow arms "C" and out through back-pressure valves "A." When this is done the arms and shafts are revolved by means of the wheels "P" on top of hollow shafts "D" breaking, stirring and loosening the dirt, etc., from the filtering material; by means of rakes "B" the beds are thoroughly broken up and the whole of the dirt loosened is carried out by the amount of water issuing from the pipes "G." The whole operation is performed in from three to six minutes.

In the larger plants the revolving of the washarms is done by bevel wheels driven from a small motor. The speed of the arms is about 80 feet per minute.

The important features of pressure filters are as follows:

(1) They are simple in construction, easily managed and are perfect and economical in operation.

(2) They purify the water continuously.

(3) The filtering material never requires changing, being cleaned in three to six minutes with a very small quantity of water.

(4) They are capable of treating all kinds of waters.

(5) Great economy of space, 1,000,000 gallons per day can be purified on an area of 600 square feet.

(6) The filters are installed in such a way that the risk of unseen leakages is minimized.

(7) They are 99% efficient from a bacteriological point.

The cost of a rapid sand filter plant under ordinary conditions will range from $8,000 to $12,000 per million gallons capacity, for

filters, coagulating basin, clear water well, and auxiliary pumping apparatus. The total cost of operation will range from $10 to $12 per million gallons.

Sterilization Processes

CHLORINATED LIME.—This process is generally used as a supplementary purification process, although in some instances it is the only process of purification. This strong disinfectant consists of a mixture of calcium hydroxide $Ca\ (OH)_2$, calcium chloride, $CaCl_2$, and calcium hypochlorite $Ca\ (Clo)_2$. On account of the active chlorine it contains it will destroy all bacteria in a few hours in extremely dilute solutions. Water thus treated is perfectly harmless, although in some instances its taste is impaired.

The sterilization of potable waters by the use of chlorinated lime was first put in operation for the Jersey City Water Supply Co. at Boonton, New Jersey, in connection with the supply of Jersey City. Since then it has been employed in connection with nearly every water supply throughout the country.

The utility of this process has been established beyond dispute as an adjunct to sedimentation and filtration, either slow or rapid sand. It cheapens the installation of filtration by practically eliminating for the future all necessity for slow sand filtration. The desired results of filtration being obtained more cheaply, more rapidly and on a much less area, by rapid sand filtration and sedimentation. The chlorine lime is usually added to give .25 to .60 parts per million of available chlorine. It costs about $25. per ton.

As stated above, the taste of the chlorine is sometimes objectionable. In a paper by Lederer and Bachmann of Chicago presented to the Illinois water supply association at their March 11th meeting, is set forth their findings on a series of tests to eliminate the taste. Chemicals which seemed of value for the purpose of eliminating the taste from chlorinated waters are sodium sulphite and sodium thiosulphate, both of which are strong reducing agents and form tasteless compounds when brought into contact with chlorine.

For .01569 gm. of chlorinated lime containing approximately 33 per cent of available chlorine, .01815 gm. of crystalline sodium sulphite was required or 1.2 pound of sulphite for each pound of lime. No harm can be done with a reasonable overdose. There are, however, serious drawbacks to the continued use of sodium sulphite, one of which is the fact that it deteriorates readily forming sulphates which are completely inert as far as taste removing properties are concerned.

The sodium thiosulphate, $Na_2\ S_2\ O_3$, 5aq. has striking advantages over the soldium sulphite. The theoretical quantity of thiosulphate necessary to complete the reaction and remove the taste as well as odor coincides always with the amount necessary to satisfy the total available chlorine in the chlorinated lime employed. The acids formed in the reaction immediately combine with the bases to form neutral salts.

For one pound of chlorinated lime containing approximately 33% of available chlorine, the theoretical quantity would be 0.28

lbs. of crystalline thiosulphate, or approximately 30% of the weight of chlorinated lime. Any harmful effects from an excess of thiosulphate is impossible. It is recommended that the application of thiosulphate be in quantities of one-half of the quantity of the chlorinated lime to be on the safe side at all times. The price of the commercial preparation of sodium thiosulphate is cheaper than that of chlorinated lime. The combined cost of the treatment is within easy reach of a community since it adds about 40% to the cost of the chlorinated lime. Even when less than the theoretical quantity of thiosulphate is added, it is bound to lessen the frequency of complaints.

It might be pointed out that the thiosulphate stops the germicidal action of chlorine the moment it comes in contact with the treated water. This is not serious, however, as the destruction of bacteria by chlorine is extremely rapid, in most cases completed in five minutes. It is recommended, however, that a margin of at least ten minutes be allowed before an addition of thiosulphate. Where the treated water is directly discharged into mains, without previous storage, provisions will have to be made to dose the treated water continuously at a point where disinfection has been practically completed.

Ultra-Violet Ray Sterilization.—Within the last few years a great deal of work has been done in Europe in the development of ultra-violet ray for water sterilization and it may be safely said that the ultra violet ray sterilizing system is now an industrial process.

The treatment of water on a large scale with ultra-violet rays requires preliminary clarification by means of filters since the suspended particles will prevent the action of the rays on the bacteria. Filtration at three to ten times the speed of normal biological sand filtration for the same water is sufficient to free the water of matter in suspension. An existing biological filter could multiply its output to a very great extent and produce a better effluent if combined with ultra-violet ray treatment. Once the water is free from suspended matter the speed and the depth of flow past the ultra-violet light have to be fixed according to the specific transparency of the particular water.

The Engineering Record of Dec. 10, 1910, describes an apparatus which is running at different places in Europe; one plant at Naromme les Ronen had been in continuous service for two years and a half and gave constantly sterile water. The water is sand filtered and then passed at a speed of 130,000 gal. per 24 hours through the rays of a one h.p. lamp.

For large city plants, however, a one h.p. unit is too small; hence a new type of lamp was constructed in July 1913, with the following objects in view:—To locate the lamp as close to the water as possible, to use as much of the light as possible, to produce ultra-violet rays with a minimum of electric energy, to run the lamps so that they would have economic life and finally to stir up the water during its exposure so as to turn over all microscopic particles which might allow bacteria to hide in their shadows.

Theoretically an extremely short exposure is needed, scarcely

more than a tenth of a second at a distance of one inch from a lamp, to sterilize the water completely. It is safer, however, to lengthen the period of exposure as is the practice with the new type of lamp.

This new apparatus is called the pistol lamp. It runs on 500 volts and requires 3 amperes. Its peculiar luminous tube is "U" shaped, the two branches of the "U" being very close together. The entire luminous part of the lamp is enveloped by a two inch quartz tube, which forms the lamp chamber, separating the lamp from the water. In the new apparatus practically all the light enters the water while the older apparatus allowed only about 60 per cent. of the light to be used. The efficiency of the lamp is increased not only by its peculiar shape but also by a greater production of ultra-violet light than one would expect from the wattage. The water to be sterilized is passed through a canal in such a way as to keep the water under the influence of the light.

C. B. Jackson, '07, and F. C. Lewis, '08, are engaged in contracting in Toronto under the firm name of "Jackson-Lewis Co. Ltd." with offices in the Bell Telephone Building.

A. G. Lang, '03, and E. R. Lawler, '10, formerly with the Toronto Hydro Electric System, are now with the Hydro Electric Power Commission of Ontario.

A. W. J. Stewart, '08, is general manager of the Toronto Hydro-Electric System, 226 Yonge St., Toronto.

W. A. Cowan, '04, is resident engineer for the Intercolonial Railway at Truro, N.S.

S. B. Iler, '08, formerly with the Brantford Hydro-Electric System is now at Vegreville, Alta., with Maxwell & McKenzie, consulting engineers, of Edmonton.

F. E. Watson, B.A.Sc., '11, has gone to Edmonton, Alta., for the summer to traverse some lakes in the vicinity of the city.

J. A. P. Marshall, B.A.Sc., '14, formerly with the Department of Public works at Medicine Hat, Alta., has recently accepted a position with the Department of Public Works of Ontario as resident engineer in the Highways Department for the counties of Middlesex, Perth, Oxford and Waterloo, with headquarters at the county buildings, London, Ont.

T. A. Fargey, B.A.Sc., is with the construction department of the Canadian General Electric Co. at Winnipeg, Man.

R. E. Lindsay, B.A.Sc., '14, is in the erection department of the Hamilton Bridge Works Co., of Hamilton, on construction work throughout Ontario.

A. A. McQueen, B.A.Sc., '11, is with the Northern Electric Co. at Winnipeg, Man.

W. S. Winters, B.A.Sc., '13, is with Speight & Van Nostrand, surveyors, Toronto.

O. M. Falls, B.A.Sc., '14, is engineer in charge of the construction of new pavements at Oakville, Ont.

TWO TYPES OF GERMAN SEWAGE SCREEN

P. Gillespie, C.E.
Associate Professor of Applied Mechanics

The processes taking place in the present day sewage treatment plant may be classified as mechanical on the one hand and chemical and biological on the other. The former involve the removal of the grosser solids either by screening or sedimentation, or both, and the latter embrace whatever else is employed, be it land treatment, filtration or sterilization. The object sought in the mechanical treatment is sometimes merely the removal of inorganic and non-putrescible matters which will not yield to subsequent treatment and which, if left, would only burden the processes to follow; sometimes such a reduction in the amount of visible organic matter that the effluent may be discharged into a body of water or a stream without occasioning offensive conditions or undue pollution; sometimes the preparation of the sewage for subsequent treatment where impairment of function would result from the presence of an undue amount of suspended matter and sometimes the removal of only those coarser entities which, if permitted to remain, might choke pump passages or other channels.

Obviously, then, the means to be employed in the mechanical treatment of a sewage must be selected with an eye to the end to be achieved. Screening and sedimentation are in their results identical. Screens, if sufficiently fine, will produce as great a clarification as sedimentation tanks of common proportions. If sewage is to be prepared for tanks of the Emscher type, which are essentially devices for the treatment of sludge, coarse bar screens are all that is necessary since there is no object in arresting anything except that which, through its greater size, might choke the six-inch slots at the bottom of the sedimentation chamber or the sludge discharge pipes. The use of fine screens in such a case will result in the production of two sludges instead of one, for the disposal of one of which, little or no provision may have been made. The screens ordinarily employed by the Emscher Board consist of ¾-in. bars spaced about 2½ ins. centre to centre. Similarly for the protection of sewage pumps, coarse screens are adequate.

It is difficult to give an approximate estimate of either the quantity of suspended matter in sewage or of the amount which a given screen is likely to remove. These things are influenced by so many variables that a generalization is well nigh impossible. Even where screens of the finest mesh practicable are employed, the bulk of the suspended matter is too finely divided to be intercepted at all. At Providence, R.I., by a grating with bars 1 inch in the clear 41 pounds of screenings per million U.S. gallons of sewage was reported as the average for the year 1906. This would be equivalent to one cubic foot nearly. An experimental Riensch-Wurl screen at Dresden with slots 1 mm. (1-12 inch) wide under test prior to the installation of the present plant, removed some 23 cubic feet of screenings per million gallons. It must be remembered, however, that German

sewages are much more concentrated than those of American cities. Mr. Weand's rotating screen at Reading, Pa., with wire cloth having meshes 1-40 inch square, according to official reports, yields 19 cubic feet per million gallons. This represents only 42% of the entire matter in suspension. Mr. Irving Nevitt, superintendent of the Morley Avenue Disposal Works, Toronto, informs the writer that the coarse bar screens at that station separate about 3¼ cubic feet per million Imperial gallons. This is equivalent to nearly 4 cubic feet per million U.S. gallons. Generally speaking, experience seems to indicate that coarse screens, as coarse screens are ordinarily understood, will remove up to 10 cubic feet per million U.S. gallons, and that quantities in excess of the latter must be obtained by the use of screens of fine mesh.

On the other hand, the preparation of sewage for dilution in rivers, lakes or the sea in certain cases, constitutes the chief field of usefulness for the fine-meshed screen. Dilution has come to be regarded as a legitimate and satisfactory method of disposal, provided always that the volume of filth does not exceed the assimilating capacity of the water into which it is discharged. Sewage which is delivered at the end of an outfall sewer is often in a highly putrescible condition, and its putrefaction on the one hand robs of its oxygen, the water into which it is discharged, and on the other reduces the organic materials to stable and innocuous forms. The effect on the water is practically harmless when not used for domestic purposes until the reduction of oxygen has continued through a considerable percentage of the saturation quantity. For instance, the first indication of pollution is the disappearance of major fish life for the preservation of which 70% of the saturation volume is necessary. When the oxygen content is reduced below 30% of saturation, the condition of the water is such as to constitute a nuisance during the summer season. In 1887 Mr. Rudolph Hering advised a dilution of 1 in 22 as a basis for the design of the Chicago Drainage Canal. This ratio was afterwards adopted. While the results have been in the main satisfactory, disagreeable odors at all points have not been prevented.

It will be apparent then, that a partial treatment such as is afforded by fine screening or sedimentation preparatory to discharge into lakes or rivers will result in the removal of much of the solids which create visible nuisance and in lessening by the amount of the solids thus removed, the burden on the assimilating water. Such has been the practice with most of the cities situated on the Great Lakes including Toronto, Rochester, Erie, Oswego, Buffalo and Milwaukee. In Germany, where many of the cities are located on relatively large streams, not sources of public water supply, the method is very general. The cities of the Emscher valley, Hamburg, Dresden, Frankfort a/M, Cologne, Düsseldorf, and Göttingen are a few of those that follow the mechanical treatment of their sewage by discharge into streams. With the exception of those in the Emscher valley, which since 1907 have adopted the two-story sedimentation tank, they have favored the fine screen in preference to the method of sedimentation.

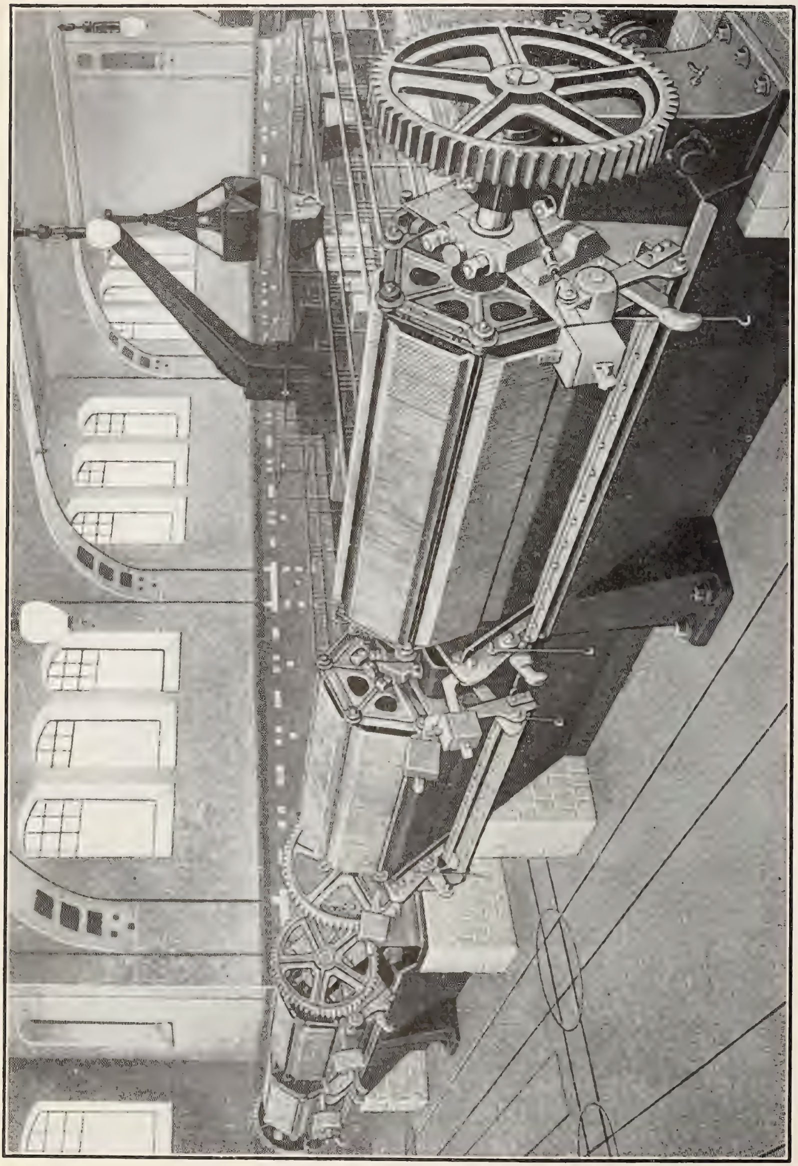


Fig. 1—Four Brunotte Sewage Screens at Hamburg, Germany. The Energy Required to operate is 1 H. P. per Screen

The choice in such cases as those cited, it seems to the writer, will depend on two things, viz.:—the relative costs of the two methods and on whether or not a satisfactory method of disposing of screenings is available. If not, the employment of the two-story sedimentation tank is a solution worthy of careful consideration. The city of Hamburg removes the screenings by scow and they are disposed of on land. It should be remembered that the manurial content is generally greater in fresh than in rotted sludge. At Dresden, where the fat content is said to be 18% of the dried residue, it is now proposed to dry the screenings and extract the grease by the use of a solvent, experiments looking toward this end having been made there on a somewhat extensive scale.

For the purpose of this article, screens may be classified as fixed and moving. The former includes, e.g., the bar screens from which the debris is removed by moving rakes operated either by hand or mechanically. The latter is represented by those types in which the particles in suspension are arrested by the screen while submerged and are removed after the screen or part of it has been lifted above the flow-line. The writer's observation leads him to believe that the latter type is much better adapted to those cases where fine screening is essential. A long distance movement of screenings over the face of a screen is likely to result in macerating and squeezing through the screen much of the arrested matter. Rakes, for example, moving over bar screens from below the water line to a place of discharge well above it, are always observed to lose much of their burden on the way. The removal of the material in the quickest possible way and without affording an opportunity for it to be crushed through openings seems to be fundamental and essential to the successful working of a fine-meshed screen. Obviously this is best accomplished in the moving type.

Of those continental fine screens familiar to American engineers, the Brunotte and the Riensch-Wurl rotating screen are probably best known. These are both of the moving type.

The Brunotte screen has been installed at Hamburg, Schöneberg, Crefeld and some other places within the German Fatherland. A fair conception as to its operation may be had from an examination of half-tone illustration, Fig. 1, and the line drawings, Figs. 2 and 3. Figure 1 is from a photograph of the installation at Hamburg, the great shipping and industrial metropolis of Germany. This city is situated on the Elbe some 50 miles from its mouth and has a population of approximately one million. The sewage from the city, after screening as its only treatment, is discharged through three outlets into the river. Enquiry elicited the information that there has been no sludging up of the bed of the river and the belief seems to be general that accumulations, if they form at all, are eventually carried out to sea by the current. The dilution at times of minimum flow is 1 in 100.

Structurally, this screen consists of a well braced steel frame, rectangular in form, whose plane is placed transverse to the line of the flow in the screening chamber and inclined upward in the

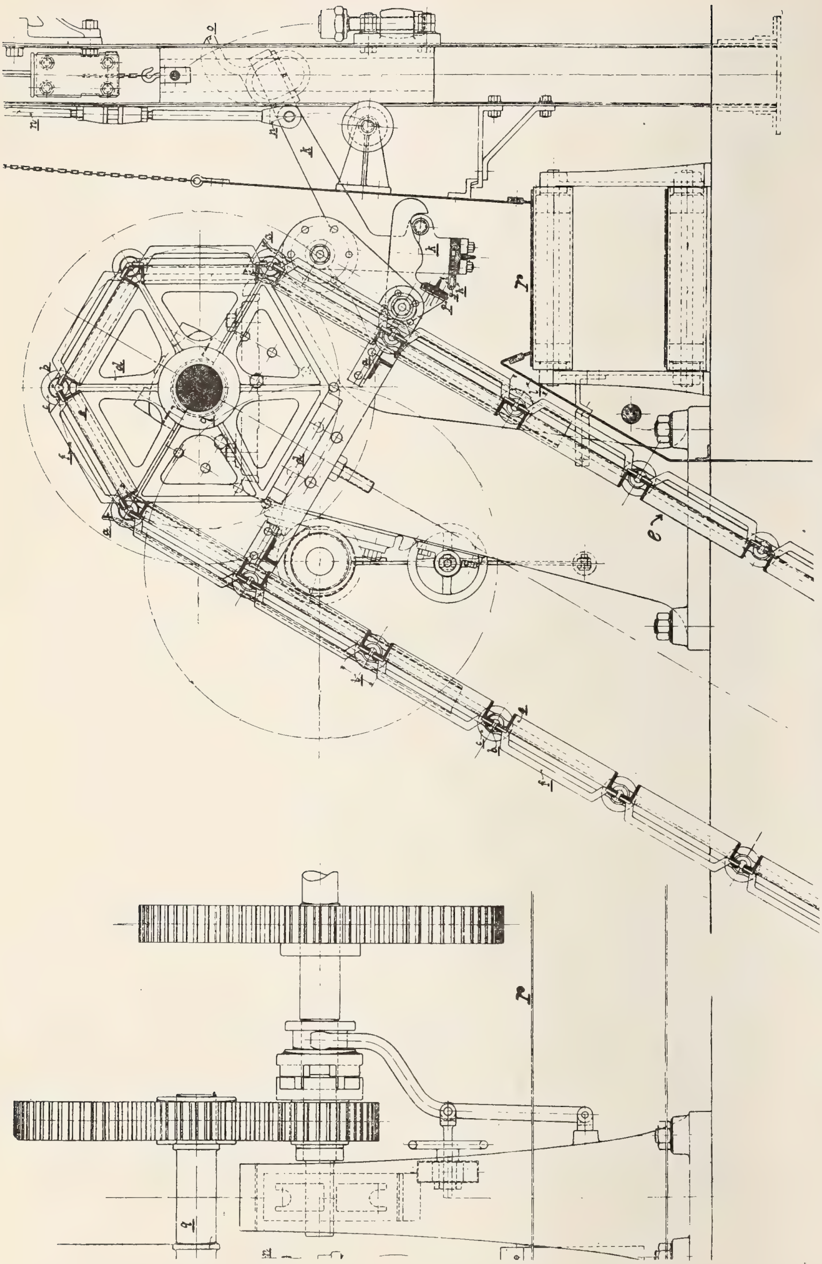


Fig. 2—Details of the Brunotte Screen

direction of flow at an angle of 60° with the horizontal. Along its upper and lower edges are attached shafts each bearing two sprocket wheels over which pass two endless chains which engirdle completely the steel frame. Of these shafts, the upper is the driver. Spanning from chain to chain and separated by suitable distances are a series of rectangular steel frames to which the metallic bars constituting the screen proper or "grid" are fastened. These bars are from 12 to 16 inches long, are made of a non-corrosive metal and are separated by distances varying from ⅛ to ⅝ inches, depending on the minimum size of particle which it is desired to arrest. In the Hamburg screen the spacing is 2/5 in (10 mm.) in the clear. In figure 2, *q* is the upper shaft, *d* a sprocket wheel and *e* the rectangular frame carrying the grid bars which are denoted by *f*. The sense of rotation is clockwise so that the rising portion of the screen is on the left. The screen bars are so shaped that they lie throughout their entire length quite clear of the grid frame, thus facilitating the cleaning of the screen by the comb to be referred to below. Upon their upper shoulders and in the recess shown at *l* is afforded a support for the larger solids which in the ordinary case fall into the belt conveyor *r* as the sections round the separate sprockets at the top of the frame. The velocity of the screen is from 1 to 2 inches per second.

To clean the grid of those smaller matters which adhere to it after the screen sections have rounded the highest point of the sprocket, a comb shown in Figure 2 and in more detail in Figure 3 is provided. This comb consists of an indented plate of rubber *g* supported by an iron plate *h* below and covered by a smooth brass plate *i* above, both of which are indented to correspond with the teeth in the rubber plate between. The width of the teeth in the metal plates is somewhat less than that of those in the rubber so that only the latter comes into rubbing contact with the bars of the screen. The comb is attached to a reciprocating lever *k* whose motion is electrically controlled and which serves to alternately advance and withdraw the comb from engagement with the grid. This withdrawal and replacement take place while the space *l* between grid sections is being traversed downward opposite the normal position of the comb. As the comb is withdrawn, the scraper *p* lying on its upper surface serves to remove the debris which has been separated from the grid just passing. This immediately falls by gravity to the belt conveyor below. The withdrawal and advance are quite rapid and the latter is complete by the time the next approaching grid has arrived in the position where combing is to begin again. The endless belt delivers the screenings to a worm conveyor, which in turn passes them to a storage hopper. The various parts of the screen are easily removable and the whole may be elevated from the water by winch if repairs become necessary. To the observer the operation of this screen seems almost ideal. It is manufactured by the Maschinenfabrik Buckau A. G., Magdeburg, Germany.

The advantages possessed by the Brunotte screen are the fact

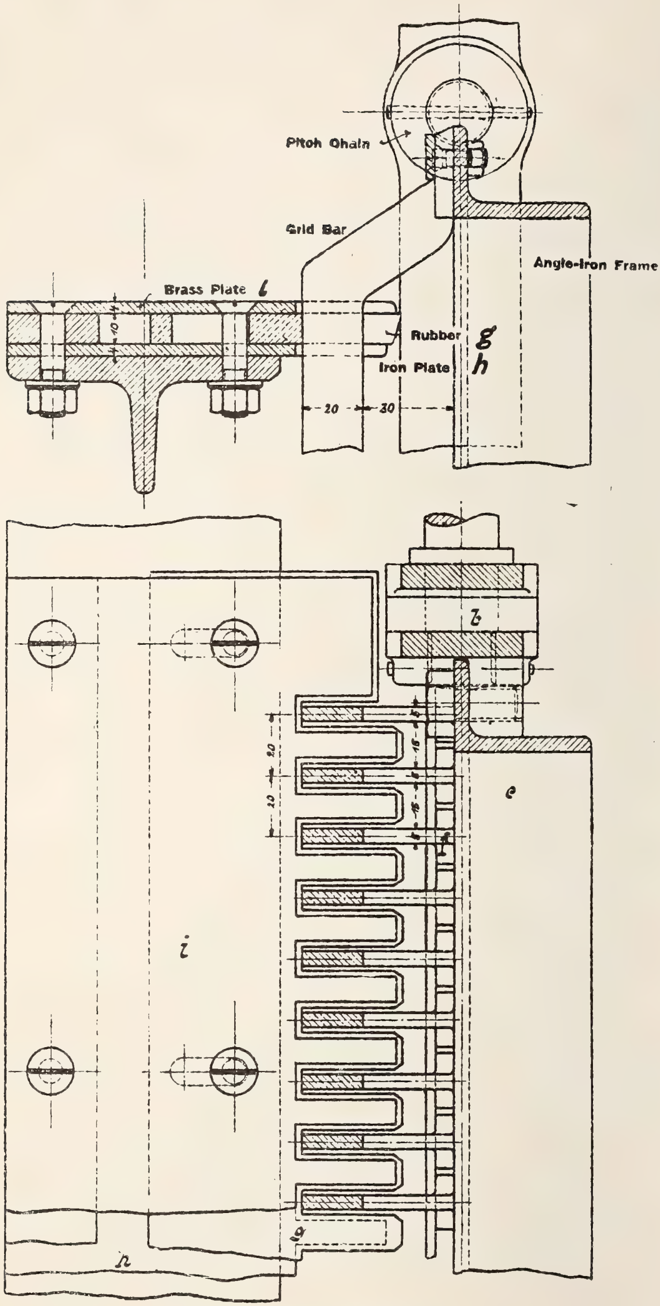


Fig. 3—The Cleaning Comb

that little of the arrested material can get pressed through the grid, that each screen bar is cleaned on three surfaces—front and two sides, that general freedom from choking is attained, that all parts may be made accessible for alterations and repairs above water and that the power consumption for operation is quite small.

The Riensch-Wurl screen is a combintaion of an annular plate and a frustum of a cone the plane of the former being inclined upward from the horizontal at from 10° to 30° and the whole being installed in the screen chamber as indicated in the diagrammatic sketch, Fig. 4. Both annular plate and frustum are made of brass perforated sections. The perforations are usually elongated rather than circular and have a width varying from 1-32 to 7-32 inch, as desired. The sewage flows through these perforations and the

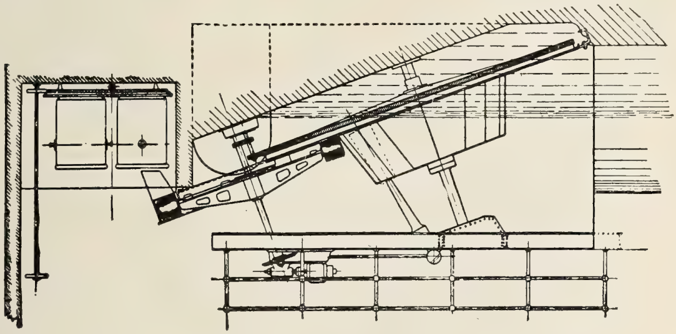


Fig. 4—Diagram of the Riensch-Wurl Sewage Screen

solids are arrested and remain upon the upstream side of the plate. The slots are made tapered, with the widened opening below, so that fine matter passing through is thereby less likely to adhere to the plates on their under sides.

The screen is revolved on its inclined shaft and as the normal flow-line is ordinarily well below the highest point of the plate,

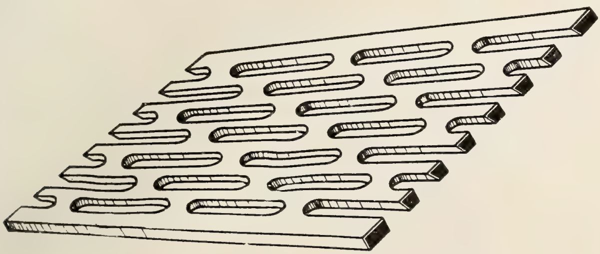


Fig. 5—Tapered Slots in Screen Plate

all parts of the submerged portion are successively brought by rotation above the water level. The loss in head is quite small. The sides of the screen chamber are accurately fitted to the shape of the

screen so that escape of sewage at the junction is well nigh practically prevented.

Cleaning is accomplished by a series of rotating cylindrical brushes attached to the extremities of the radiating arms of a revolving star-shaped spider. The sense of rotation of this spider is the same as that of the screen so that the motion of the arms while cleaning the plates of the screen is opposite to that of the plates themselves. The cleaning brushes are faced with bristles as shown in figures 6 and 7 and their sense of rotation is upward from the screen on the advancing side. These brushes are suspended from the carrying arms and each is driven through a pair of spur gears, one on the extremity of the carrying arm and the other centric with the axis of the brush itself as shown in figure 6. A little consideration will show that the operation of the driving spur A tends to

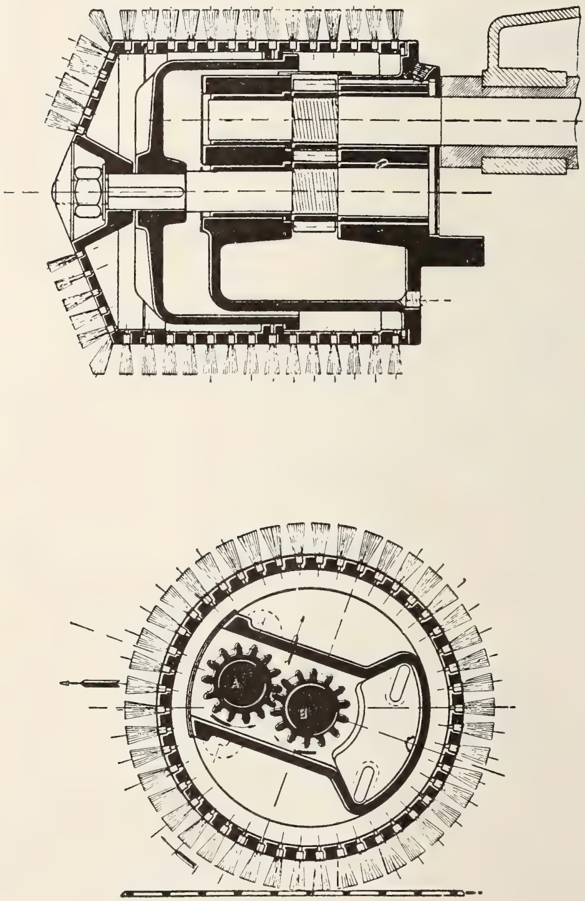


Fig. 6—The Gear Driving Mechanism of the Rotating Brushes

diminish the weight supported by the screen plates. The brushes in consequence move lightly and silently over the screen. It will be apparent also that, owing to the simultaneous motion of screen and brushes, the paths of the latter intersect each other and that each portion of the screen is brushed several times between leaving the water level and returning thereto again. The individual plates are interchangeable and easily removed so that repairs are readily made. The screenings are said to have a water content of 65% and are disposed of on land or otherwise as seems most suitable.

The city of Dresden, Germany, possesses the largest installation of Riensch-Wurl screens yet erected. This city is situated on the Elbe River and the sewage is brought to the works, in the municipality of Kadiz on the right bank of the river a few miles below the city proper, by two interceptors, each serving one side of the river. A hopper-shaped detritus tank entraps the grit which is dredged periodically therefrom by a mechanical dredger. The

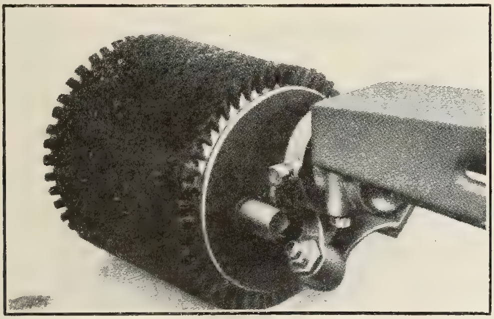


Fig. 7—Riensch-Wurl Brush Suspension

sewage is then passed through a battery of four Riensch-Wurl rotating screens each of diameter 26 feet. These may be operated in series or parallel as desired. The slots in the plates are 2 mm. x 30 mm. (1-12 x 1 1-5 in.) The plates are cleansed from time to time with a solution of soda. The arrangements provide that when the flow exceeds the capacity of one machine, a second is automatically thrown into service. A third and a fourth are similarly successively added as the volume of sewage to be treated increases. Provision is also made for by-passing to the river, the flow in excess of a pre-determined maximum in times of unusual storm. The entire installation is electrically operated.

To the visitor, the operation of this plant appears almost faultless The mechanical equipment seems perfect and the cleanliness is all that the most exacting could desire. The Sanitation Company of New York are the American representatives for these screens and to them the thanks of the writer in permitting the use of several illustrations are due. Over forty different installations to date of the Riensch-Wurl screen have been made not only in Germany but in Russia, France and Scandinavia also.

THN JUNGLE JOB

I said to myself, "I am through pioneering,
I'm sick of the wilderness, lonely and rough,
I'm sick of the graders' camp, built in a clearing,
I'm weary of laborers, hairy and tough;
I'm tired of the outfit, the bed and the ration,
The steam shovel's puffing, the shock of the blast—
I want to go back where there's civilization,
The fun and the frolic I knew in the past.

"The life that has savor and vim in,
The sights and the noises of towns,
The laughter and lure of the women,
The glitter of jewels and gowns;
I'm done with this business forever,
I'm off to see 'cities and men,'
And once I have landed, I'll never
Come back to the 'Jungle' again."

So I made for the city of wonder and glamor
The city whose glory had shone in my dreams,
I plunged with delight in its hurry and clamor,
Its welter of hopes and ambitions and schemes,
I reveled again in the food and the raiment,
The music and lights and the movement and mirth,
And I said to myself, "There is no form of payment
Can tempt me again to the outposts of earth."

But in spite of the pleasuring places,
In spite of the vast city's thrill,
The spell of the unconquered spaces
Came following after me still;
At night it would suddenly wake me
By day it would whisper and then
I knew it was trying to make me
Come back to the Jungle again.

I had thought that the softness of cities would tame me
I fought with the thrall of a life I reviled,
But the lure of the game I had played overcame me
—The struggle with Nature far out in the wild.
The flesh-pots were sweet, but they never could hold me,
I packed up my kit and I made for the trail,
And now I believe what the Old Timers told me,
"The spell of the wilderness never can fail."

I'm back to the "furthermost farness,"
I'm way, way "ahead of the steel,"
I'm wearing my engineer's harness,
The gravel is under my heel;
The dreams of the city still bind me,
The call of it comes to my ken,
But somehow I left it behind me,
I'm back to the "Jungle" again.

By Berton Brayley, in "Power."

APPLIED SCIENCE

INCORPORATED WITH

Transactions of the University of Toronto Engineering Society

DEVOTED TO THE INTERESTS OF ENGINEERING, ARCHITECTURE AND APPLIED CHEMISTRY AT THE UNIVERSITY OF TORONTO

Published every month in the year by the University of Toronto Engineering Society

Subscription Rates

Per year, in advance	$2.00
Single copies	.20

Advertising rates on application.

Address all communications:

Applied Science,
Engineering Bldg., University of Toronto,
Toronto, Ont.

EDITORIAL

It is with an unrestrainable feeling of profound sorrow that we go to press with this issue of Applied Science. It conveys to our readers the very regrettable announcement of the death of their most cherished friend, our Beloved Dean Galbraith, whose heart had a resting place for every student and graduate who had come in contact with his benign influence either in the "School" or in their professional work. We are unable to express in words the feeling of loss that we have experienced in the departure to the Beyond, of our chief advisor and our kindest friend, whose large and sympathetic

heart had enthroned him in the mind and heart of every "School" man.

Since the birth of APPLIED SCIENCE, he has been our constant guardian and helper, to whom we always felt free to go for counsel. The Dean's keen interest in his graduates no doubt accounted in some degree, for the interest which he took in the "School" journal, since it was the one medium of keeping them in touch with each other and with the institution of their early training.

When we say that APPLIED SCIENCE has kept the graduates in touch with the "School," we might better say that it has kept them in touch with the Dean, for his whole life and energy was centred in the institution of his founding and building, and we trust that in future it will serve to keep them in touch with the monument which he has raised in the record of engineering education, and which will stand throughout the future eras of history as a monument to the unsurpassed and indefatigable work which he has accomplished in the interest of the profession, the School, and the members of the student family.

Not only has Dean Galbraith always manifested a kindly interest in the School journal, but in spite of the fact that his many duties demanded so much of his attention, he has contributed freely toward material for publication therein. In Volume III, No. 5, dated March 1910, appears an extensive article by him, on "The Elastic Arch."

In the issue of December, 1908, appears an address by Mr. E. W. Stern, C.E., '84, delivered on the occasion of the presentation of Dean Galbraith's portrait to the University of Toronto. In it is portrayed the respect which the early graduates hold for their beloved preceptor.

Without our leader, it is incumbent upon the graduates, and upon our earlier graduates in particular, to be constantly alert, always watchful of the union which our Dean has so proudly and so successfully effected, lest the glory which is due him through its continued growth and stability, should lose any of its rightful brilliance and effectiveness as a result of thoughtless neglect. The "School" will always mark the life of our late Dean in the pages of history, and if we are true to the debt which we owe him, we will not allow the growth of the "School" to be stunted, nor the union among "School" men to be weakened, but will converge our energies toward keeping bright and prominent, the monument of his building.

He has made the upbuilding of the engineering course in the University and the unification of the graduate body, his life work. It was his desire to see both prosper, and if we do our utmost to continue the good work from which death called him away, we will accede to his most ardent wish.

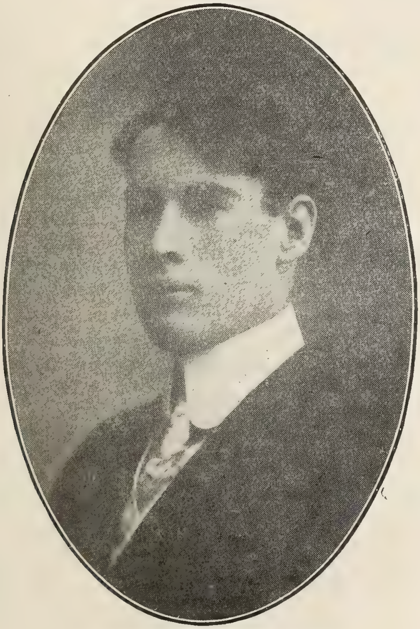
SEDGEWICK-SCOTT

On July 1st at noon, Mr. A. Sedgwick, '09, of the Department of Public Works of Ontario, was married to Miss Annie Irene Scott of Inglewood, Ont. After September 1st, Mr. and Mrs. Sedgwick will reside at 67 Fulton Ave., Toronto. APPLIED SCIENCE joins in extending congratulations.

OBITUARY

FREDERICK J. BEDFORD, '08

It was with regret that we learned of the sudden death of one of our graduates, Mr. Frederick J. Bedford, of class '08, son of Rev. J. Bedford, of Pickering. Mr. Bedford, was in the employ of the Canadian Copper Co. at Copper Cliff, Ont. On June 25th, while he was repairing some machinery at the ninth level in one of



F. J. BEDFORD, '08

the mines, a car was accidentally lowered, which struck the deceased's head, killing him almost instantly.

Mr. Bedford was born at Thessalon on May 30th, 1885. After receiving a public school education he came to Harboard Collegiate. He afterwards attended Albert College and later enrolled in the Faculty of Applied Science and Engineering at the University of Toronto, where he took a course in mining engineering with class '08.

For some time after graduating he was employed at Creighton Mine, near Sudbury, and later became superintendent of the Crane Hill Mine, also near Sudbury. For some time he was engineer for the Dome Mine at Porcupine before going to Copper Cliff, where he was engaged with the Canadian Copper Co. until the time of his death.

In his demise the engineering profession has lost a man whose diligent application to his work had won him much success and his

friends have lost a fellow worker whose worthy attributes have proven him a true friend.

He is survived by his wife, who was Miss Pearl Clark, of Souris, P.E.I., his father and mother and one sister, to whom we extend our most heartfelt sympathy.

W. N. ALLAN, '15

A very sad death occurred at Oakville, Ont., on Sunday, July 19th, when Mr. W. N. Allan, son of Mr. and Mrs. J. S. Allan, of Nelson, B.C., who had just completed his third year in mining engineering at the "School," was drowned at the age of twenty-six years in the heroic attempt to rescue a man and two children, who had been precipitated into the lake from a capsized canoe.

There was a strong wind blowing of a rather squally nature, and while Mr. Allan, who was on the shore, was watching the man put up a sail, the canoe suddenly upset, throwing the occupants into the lake. Forgetful of himself and thinking only for the safety of the struggling trio, Mr. Allan, without even taking time to remove his shoes, plunged into the water and began to swim to their rescue. Before the young hero had reached them, the occupants of a near-by boat, who had observed their plight, at once went to their rescue.

Upon seeing that they were all safely aboard, the swimmer started back to the shore, but when he was about 150 feet from land he was seen to falter and he went down. The boat which had already effected the triple rescue was soon upon the spot and the body was recovered, but although an attempt at resuscitation was made immediately, all efforts proved of no avail. A physician who had been summoned as soon as the boat reached shore, made an examination, and found that death had been due to excitement and shock which had effected the heart of the swimmer, already under the extra strain of swimming, fully attired.

Mr. Allan was of quiet and unassuming nature, but underneath the quiet surface there flourished a true-hearted manhood, pillared with qualities of character which prompted him to an action of undaunted bravery, resulting in the sacrifice of his own life in an attempt to save others, and placing his name in the annals of history among those whose largeness of heart and whose thought for their fellow-men has led them to suffer death that others might be saved.

The circumstances surrounding his demise are indeed very sad. His heroic efforts deserve the attention of everyone and it will be with a feeling of profound regret that his fellow-students will learn of his death. The remains were interred in the cemetery at Oakville on Wednesday, July 22nd. Professor Haultain and Mr. W. A. MacLean were the official representatives of the University of Toronto and the Public Roads and Highways Department of the Provincial Government, respectively, at the funeral. We extend to the relatives of the deceased our sincerest condolence in their very sad bereavement.

ROBERT G. M. STRATHEARN, '13

On Tuesday afternoon, July 7th, about three o'clock, Mr. R. G. M. Strathearn met death when he was overcome by gases in a sewer on Argyle St., Toronto. Mr. Strathearn, who had always taken particular pains with his work, wished to verify some measurements which he had already made, and entered the sewer for that purpose. While making the measurements he felt the opression from the gases and attempted to reach the manhole through which he had entered, but was overcome and expired before a rescue could be effected.

Deceased, who was twenty-three years of age, was the son of Mr. George Strathearn, of Midland. He received his Public School and High School education in the northern town and entered the University in the department of civil engineering in 1909, with class '13. Upon the completion of his second year he was appointed to the staff of the sewer department, City Hall, which position he occupied until the time of his death. He had always exercised exceeding care with his work, and it was that careful sense of duty that prompted him to accept a risk, which unfortunately resulted in his death.

The body was sent to Midland on Thursday, July 9th, for interment. Deceased is survived by his father, three brothers and two sisters, to whom we extend our sincere sympathy in their bereavement.

The following "In Memoriam" was written by a close friend of the deceased:

He died, doing what he believed to be his duty, and where it called he was not found wanting. One of the keynotes of his life was thoroughness, and accuracy possessed him. He was not, therefore, lacking in those qualities that go to make up a hero.

"Come on my lads, let us descend!" so spake Bob to his men,
He led the way where DUTY called; there was no flinching then:
But human skill could not foretell the issue of that act,
For when he reached the air above, the spark divine he lacked.

Ne'er mind, 'tis well, for God doth know, he died with a good name,
Nipped in the bud—before his life had blossomed into fame:
Though few his years of service were, their quality was high
And with a record such as that, no man's ashamed to die.

Some thoughts from Holy Writ may here, be counted apt and right.
Whate'er his hand found well to do, he did with all his might,
He who'd have friends must friendly be to those he meets, and kind;
This of our Bob was also true,—he had a willing mind.

His life though short, we know, dear friend, has not been lived in vain,
God suns and waters precious seed; Behold it lives again:
By His good grace we hope to meet our much loved boy once more
O may we all a mansion have, where Christ has gone before.

MacLean, B.A., '09, is engaged in switchboard and power plant designing, with the Canadian General Electric Co., at Peterboro, Ont. His permanent address is Orillia, Ont.

MacLennan, A. L., '02, has 115 Avenue Road, Toronto, as his address.

MacLennan, G. G., '10, formerly with the Foundation Co. Limited, at Smith's Cove, N.S., is at present on a trip through Western Canada.

MacLeod, G., '07. No record.

MacLeod, D. D., '10, is with the Department of Interior, at Calgary, Alta.

MacMillan, G., '01, is with the Topographical Surveys Branch of the Department of Interior at Moose Jaw, Sask.

MacMurchy, J. A., '96, is chief draftsman in the turbine department of the Westinghouse Machine Co.

MacMurchy, H. G., '10, is employed as generating and sub-station designer for the Toronto Power Co.

MacPherson, A. R., '13, is with P. H. Secord & Sons, contractors, of Brantford, Ont.

MacPherson, N. W., '09. No record.

MacTavish, H. J. '10 is with the Transmisson and Power Co., at Hamilton, Ont, His address is Terminal Station, Hamilton, Ont.

MacTavish, W. H., '13, is with the International Boundary Surveys Branch, Department of Interior, Ottawa. He is at present in Alaska in charge of a party on boundary survey work.

Mc

McAllister, J. E., '91, has a practice as consulting engineer at 15 King St. W., Toronto, Can.

McAllister, A. L., '93, has a practice as consulting engineer. His office address is 612 Continental Life Building, Toronto.

McAlpine, D. D., '09, is with the Canadian General Electric Co., Toronto.

McAndrews, J. B., '11, has 70 Church St., St. Catharines, for his address.

McAree, J., 82. Deceased.

McArthur, R. E., '00. We do not know his address.

McArthur, A. S., '09. His address is 54 Rathnally Ave., Toronto.

McAuslan, H. J., '03, is on the staff of the T. & N. O. Railway at North Bay, Ont.

McBride, A. H., '02, is with the Hydro Electric Power Commission, Continental Life Building, Toronto.

McBride, T. C., '10, is with the Western Construction Co., at Regina, Sask.

McCollum, C. R., '09, is with the Toronto Hydro Electric system. His address is 77 Roper Ave., Toronto.

McConnell, A. W., '06, is lecturer in architectural design at the University of Toronto, Toronto, Ont. He has been in Paris, France, during the past year, taking a post graduate course in architecture.

McCordick, A. S., '09, is assistant to the city engineer, Sault Ste. Marie, Ont.

McCuaig, O. B., '04, is superintendent of the Entiat Light & Power Co., Wenatchee, Wash.

McCuaig, P. J., '09, is with the Westinghouse Machine Co., Pittsburg, Pa.

McCulloch, A. L., '87, has a practice as engineer and surveyor at Nelson, B.C.

McCurdy, J. A. D., '07. His last address with us is Baddeck, N.S., where he was with Graham Bell, Esq.

McDougall, J., '84. Deceased.

McDougall, S. G., '10. We have not his present address.

McDowall, R., '88, is city engineer for Owen Sound, Ont.

McEachern, J. A., '11, has Strathburn, Ont., as his home address.

McElhanney, T. A., '10, is in Vancouver, B.C.

McElroy, R. W., '11. No record.

McEntee, B., '92, has a stationery store at 38 Queen St. E., Toronto.

McEwen, G. G., '04, is with T. H. Dunn, O.L.S., Winchester, Ont.

McEwen, H. J., '11. No record.

McFayden, A. J., '11, has 12 Lee St., Quebec, as his address.

McFarlen, G. W., '88, is on the city

engineer's staff, roadways department, Toronto, Ont.

McFarlen, T. J., '93, is chemist for the Antikokan Iron Co., Port Arthur, Ont.

McFarlane, J. A., '03, is chief draftsman with the Hamilton Bridge Works, Hamilton, Ont.

McFarlane, W. G., '04, is engineer and surveyor in the Peace River District.

McFarlane, J. B., is a Dominion land surveyor. His address is 60 Lonsdale Rd., Toronto, Ont.

McFaul, W. L., '13, is in the city engineer's office, Port Arthur, Ont.

McGarry, P. G., '10, has Merritton, Ont., for his home address.

McGeorge, W. G., '08, has a practice as civil engineer and land surveyor at Chatham, Ont.

McGhie, W. G., '11, is with the Canadian Crocker-Wheeler Co., St. Catharines, Ont.

McGibbon, C. P., '04, is with the Canadian Westinghouse Co., Hamilton.

McGorman, S. E., '06, has Box 393 Walkerville, Ont., for his address. He is assistant engineer, Canadian Bridge Co. Limited, Walkerville, Ont.

McGowan, J., '95, is associate professor of Applied Mechanics at University of Toronto, Toronto, Ont.

McGregor, W. W., '05. Deceased.

McGregor, J. M., '08, has Ridgetown, Ont., for his home address.

McGugan, D. J., '07, is a member of the firm, Burnett & McGugan, civil engineers and land surveyors, New Westminster, B.C.

McIlwraith, D. G., '06, is chief draftsman for the Goldie & McCulloch Co., Limited, Galt, Ont.

McIntosh, A. H., '07, is with the Illinois Steel Co., Chicago, Ill.

McIntosh, W. G., '09, is with the Herbert Morris-Crane at Hoist Co., Toronto.

McKay, O., '85, has a practice as civil engineer and surveyor at Waterville, Ont.

McKay, C., '04, deceased.

McKay, W. N., '95, is manager of the Bank of Hamilton at Georgetown, Ont.

McKechnie, F. H., '09, has for his address 303 McKay St., Montreal, P.Q.

McKenzie, D. A., '11, is meter inspector with the Toronto Hydro Electric system.

McKenzie, D. W., '05, is draftsman in the engineering department of C. N. Railway, Winnipeg, Man.

McKenzie, J. A., '06, is a member of the firm of McKenzie, Broadfoot & Johnston, Vancouver, B.C.

McKim, L. R., '10, has Wyecombe, Ont., as his permanent address.

McKinnon, H. L., '95, is vice-president of the C. O. Bartlett & Snow Co., Cleveland, Ohio.

McLaren, A. J., '11, has 221 Home St., Winnipeg, Man., as his address.

McLean, C. A., '05, is with the Canadian Westinghouse Co., Limited, at Toronto, Ont.

McLean, W. N., '05, has Erin, Ont., as his home address.

McLean, L. A., '08. Deceased.

McLeish, A. G., '11, is with the Canada Crude Oil Co., 507 Lumsden Bldg., Toronto.

McLellan, R. A., '11. No record.

McLennan, A. L., '02, is in the office of the York County engineer.

McLeod, G., '09, is electrician for the Electric Light & Railway Co., Waupaca, Wis.

McMaster, A. T. C., '01, is practicing as engineer and contractor, Toronto, Ont.

McMaster, W. A. A., '08, is a member of the firm, McMaster & Christie, land surveyors, McKay & Adam Block, Prince Albert, Sask.

McMillan, J. G., '00, of Box 431, New Liskeard, Ont., is inspector of Mines, Cobalt and Porcupine Districts, Ont.

McMillan, D., '04. No address on fyle.

McMillan, V., '09, is branch manager, Trussed Concrete Steel Co., at Fort William, Ont. (Kahn System of Reinforcement); head office, Walkerville, Ont.

McMordie, H. C., '08.

McNab, J. V., '06, is resident engineer with C. P. Railway at Moose Jaw, Sask.

McNaughton, A. L., '03, is with the Grand Trunk Pacific Railway Co., at Prince Rupert, B.C.

McNaughton, F. W., '98, is Deputy

Minister of Public Works, at Winnipeg, Man.

McNeill, F. W., '07, is with the Canadian General Electric Co., at Peterboro, Ont.

McNiven, J., '10, is government inspector on elevator construction at Moose Jaw, Sask.

McPherson, A. J., '93, is Deputy Minister of Public Works for Saskatchewan, at Regina, Sask.

McPherson, J. A., '06, is a student in the faculty of medicine, University of Toronto.

McPherson, W. B., '11, is a student at law, Osgoode Hall, Toronto.

McQuarrie, M. K., '07, is resident engineer for the C. P. Railway, at Revelstoke, B.C.

McQueen, A. A., '11, is assistant manager of the Winnipeg Hydro Electric system, Winnipeg, Man.

McRoberts, A. A., '08, is with the T. & N. O. Ry. at North Bay, Ont.

McSloy, J. T., '10, is textile manufacturer, St. Catharines, Ont.

McTaggart, A. L., '94, is in the office of A. G. McKie, consulting engineer, Rockefeller Building, Cleveland, Ohio.

McVean, H. G., '01, has a practice as contractor and engineer at Regina, Sask.

M

Mace, F. G., '05, was patent examiner in the Department of Agriculture, at Ottawa, Ont., when last heard from.

Madden, J. F. S., '02, is on the staff of the erecting engineering department for the Canadian General Electric Co., at Winnipeg, Man.

Madge, N. G., '08, is chief chemist for the Continental Rubber Co., of New York.

Madill, H. H., '11, is a member of the firm, Craig & Madill, architects, Manning Chambers, Toronto. He is also lecturer in architecture at the University of Toronto.

Main, W. T., '93. His last address on our fyle is Silverton, Oregon.

Maisonville, A. W. R., '10, was on the designing staff of the Dominion Bridge Co. when last heard from.

Malcolmson, W. S., '07. His last address with us is Haileybury, Ont. We do not know his present occupation.

Malone, J. E., '08, has Brechin, Ont., for his home address.

Manning, N. H., '09, is district manager for the Canadian Inspection and Test Laboratories, Limited, Toronto.

Manson, G. J., '04, is engineer for the Grenville Board Co., Penetang, Ont.

Manson, A. B., '09, is city engineer for Stratford, Ont.

Marani, C. J., '88, has a private practice as consulting structural engineer at Anacortes, Wash. He is also Pacific Coast manager for the Russia Cement Co., of Anacortes.

Marani, V. G., '93, is city building inspector, City Hall, Cleveland, Ohio.

Marlatt, K. D., '08, is chemist and tannery superintendent for the Marlatt & Armstrong Co. Ltd., Oakville, Ont.

Marr, N., '10, is at Campbellford, Ont., employed on the Trent Valley Canal work.

Marriott, F. G., '03, is chemist and engineer of tests at the Department of Works, foot of Princess St., Toronto.

Marrs, C. H., '02, is designing engineer for the Hamilton Bridge Works, Hamilton, Ont.

Marrs, D. W., '06, is designer and estimator for the Riter-Conley Mfg. Co., Pittsburgh, Pa. His address is 732 Summerlea Ave.

Marshall, R. J., '08, is town engineer for Trenton, Ont.

Marshall, S. A., '07, of 44 Eleventh Ave., Lachine, P.Q., is with the Dominion Bridge Co.

Martin, F., '87, is a practising physician. We have not his present address.

Martin, J. C., '11. We do not know his address.

Martin, W. H., '10, is in the city architect's department, City Hall, Toronto.

Martin, T., '96. We have not his present address on fyle.

Martindale, E. S., '09, has a practice as land surveyor at Aylmer, Ont.

Martyn, O. W., '09, is engaged in survey work at Swift Current, Sask.

Mason, D. H. C., '07, is a member of the firm, Akers, Mason & Bonnington, chemical engineers, Toronto.

Matheson, W. C., '01. We have not his address.

Mathison, P., '01, has 607 Jones Ave., Braddock, Pa., as his address.

Matthews, A. C., '10. His address is 89 St. George St., Toronto.

Maus, C. A., '03. We have not his address on fyle.

Maxwell, W. A., '06. We have not his address on fyle.

Maynard, H. V., '07, is with the Canadian General Electric Co. at Toronto, Ont.

Meader, C. H., '10, is engineer for the Colonization Roads Branch of the Department of Public Works of Ontario.

Meadows, C. A., '11, who took a post graduate course last year in structural engineering is now in Europe on a few months' holiday.

Meadows, W. W., '95, is with the Department of Public Works at Maple Creek, Sask.

Melson, J. W., '07, is in the employ of the Department of Works, City of Toronto, on sewer construction.

Menzies, J. M., '06, is engaged in missionary work at Wei An Hsien, North Honan, China.

Mennie, R. S., '02, was with the Crucible Steel Co. of America, at Pittsburgh, Pa., when last heard from.

Merrill, E. B., '91, has a consulting engineering practice at Moosejaw, Sask.

Merriman, H. O., '10, who until recently was first assistant engineer for the Hamilton Hydro Electric System, has severed his connections with that department. We do not know the nature of his employment at present.

Middleton, H. T., '01, has Palisade, N.J., as his address.

Mickle, G. R., '88, is mine assessor for the province of Ontario. His office is in the Parliament Buildings, Toronto.

Mickleborough, K. F., '13, is assistant engineer in the superintending engineer's office, department of railways and canals, Cornwall, Ont.

Mickler, G. J., '13, is sales engineer for the Ontario Hydro-Electric Power Commission.

Mill, F. X., '89—deceased.

Miller, D. J., '10. We do not know his address

Miller, L. H., '00, is sales agent for the Bethlehem Steel Co., Cleveland, Ohio. His address is 10218 Hampden Ave., Cleveland.

Miller, M. L., '03. His address is 845 Canton Ave., Detroit, Mich.

Miller, L. R., '06, is superintendent of the Watrous Electric Light, Power & Traction Co., Watrous, Sask.

Milligan, G. L., '08. The only address we have on fyle is Brampton, Ont.

Milligan, F. S., '10, is on the city engineering staff, Saskatoon, Sask.

Millman, N. C., '13, is with the Ontario Hydro-Electric Power Commission, Toronto.

Mills, G. G., '07, and Mills, L. G., '11, are in the contractors' equipment business at 809 Lumsden Building, Toronto.

Mills, P. E., '10, has charge of the drafting department of the Eisman Magneto Co., New York. His address is 320 West 56th Street, New York.

Minns, J. B., '07, is with the Canadian General Electric Co., at Winnipeg, Man., as sales manager.

Minty, W., '94, is with Messrs. Yates and Thom, Limited, Blackburn, Lancashire, England.

Milne, C. G., '92—deceased.

Mines, W., '93, is mechanical engineer for Hoover & Mason, contracting engineers, Chicago, Ill.

Mitchell, P. H., '03, and Mitchell, C. H., '92, have a practice as consulting engineers under the firm name of C. H. & P. H. Mitchell, consulting and supervising engineers, Traders Bank Bldg., Toronto.

Mitchell, L. C., '11. We do not know his address.

Mitchell, B. F., '06, is on the city engineer's staff, at Edmonton, Alta.

Mitchell, A. B., '08. We do not know his address.

Moberly, H. K., '89, has an engineering and surveying practice at Yorkton, Sask.

Moffatt, R. W., '05, is instructor in the University of Manitoba, Winnipeg, Man.

Molesworth, G. N., '07, has a practice as architect at 2 College St., Toronto.

Molesworth, J. C. P., '08—deceased.

Monds, W., '99, is a member of the firm Clark & Monds, contractors and engineers, 88 St. David St., Toronto.

Monk, E. D., '08, is district transformers specialist, with the General Electric Co., Cincinnati, Ohio.

Moody, F. H., '08, is mechanical editor of the *Canadian Railway and Marine World*, Toronto.

Montague, F. F., '06. We do not know his address.

Montgomery, R. H., '03, has a practice as engineer and surveyor at Prince Albert, Sask.

Moore, H. H., '02, has a practice as engineer and land surveyor, at Calgary, Alta.

Moore, E. E., '04, is with the Ontario Hydro-Electric Power Commission, Continental Life Bldg., Toronto, Ont.

Moore, J. H., '88, is town engineer at Smith's Falls, Ont.

Moore, J. E. A., '91, is chief engineer to the C. O. Bartlett & Snow Co., Cleveland, Ohio.

Moore, F. A., '03. We do not know his address.

Moore, W. J., '06, formerly a member of the firm Morris & Moore, land surveyors and architects, Pembroke, Ont., has been appointed town engineer of Pembroke.

Moore, J. M., '07, is engineer for the McClary Mfg. Co., London, Ont.

Moore, T. R., '13, is employed at St. Catharines, Ont., as draftsman of the new Welland Ship Canal.

Moorhouse, W. N., '04, is designer for the Sproatt & Rolph, architects, Toronto.

Morden, L. W., '05. We do not know his address.

Morgan, J. P., '10, is cost engineer with the Orpen Construction Co., Toronto.

Morice, J. H., '08, is switchboard proposal engineer for the General Electric Co. at Schnectady, N.Y.

Morley, P. F., '07, is at the Meteorological Office, Toronto.

Morley, R. W., '04, is in the Topographical Surveys Branch, Department of Interior, Ottawa, Can.

Morphy, J. A., '11. His last address with us is Oshawa, Ont.

Mortimer, F. R., '10, is with the Hydrographic Surveys Branch of the Naval Service Department, at Ottawa.

Morris, J. L., '81, has a private practice as civil engineer and land surveyor at Pembroke, Ont.

Morris, C. A., '09, is with the Canadian Copper Co. at Copper Cliff, Ont.

Morton, G., '09, is city salesman for the Canadian Westinghouse Co., at Calgary, Alta.

Mowbray, F. E. H., '08, is with the Canadian Westinghouse Co., at Hamilton, Ont.

Mullins, E. E., '03, is superintendent of motive power for the Northern Railway Co., at Port Limon, Costa Rica, C.A.

Mulqueen, F. J., '13, is with the Sao Paulo Light & Power Co., Sao Paulo, Brazil, S.A.

Munro, A. H., '10, is employed on the Trent Valley Canal at Campbellford, Ont.

Munro, W. H., '04, is in the engineering department of the Peterboro Radial Ry., Peterboro, Ont.

Munro, G. R., '05, is with the Wm. Hamilton Co., at Peterboro, Ont.

The following were awarded the professional degree of C.E. (Civil Engineer) by the University of Toronto at the Convocation in June; C. R. Young, '03, P. Gillespie, '03, T. H. Hogg, '07, and S. N. Hill, '04. The professional degree E. E. (Electrical Engineer) was awarded to R. A. Sara, '09.

N. G. Keefer, B.A.Sc., '14, is with the Glass Garden Builders Co., 43 Scott St., Toronto.

H. M. Smith, B.A.Sc., '14, is with Frank Barker, bridge engineer, 57 Adelaide St. E., Toronto.

H. D. Rothwell, B.A.Sc., '14, is with the Hydro Electric Power Commission, Toronto.

W. P. Dobson, B.A.Sc., '10, who has just completed eighteen months on research scholarship work for the Engineering Alumni Association, is now in charge of the testing department of the Hydro-Electric Power Commission, at their plant on Strachan Ave., Toronto.

E. T. Ireson, B.A.Sc., '13, is with Geo. Abrey,, surveyor, Toronto.